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# THEORETICAL DEFINITION OF INSTRUCTOR ROLE IN COMPUTER-MANAGED INSTRUCTION

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# THEORETICAL DEFINITION OF INSTRUCTOR ROLE IN COMPUTER-MANAGED INSTRUCTION

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## FOREWORD

This research was performed under Work Unit Z1176-PN.01, Improving the Navy's Computer Managed Training System, as the initial phase of a project aimed at defining the role of the instructor within a computer-managed instruction (CMI) environment. It was conducted under the joint sponsorship of the Deputy Chief of Naval Operations (OP-01) and the Defense Advanced Research Projects Agency (ARPA). The views and conclusions contained in this document are those of the authors and should not be interpreted as necessarily representing ARPA's official policies, either expressed or implied.

This report describes the results of a theoretical analysis of the ideal role functions of the CMI instructor. It synthesizes concepts relevant to instructor behavior from two major learning theories, examines roles allocated to instructors by several large-scale operational CMI systems, and summarizes results of the review of available literature concerning essential CMI instructor activities. It is intended to serve as a working document from which researchers can develop a theoretically sound set of behaviors that are optimal in a CMI environment. Further reports will describe this set of behaviors and will document any discrepancies between this ideal role and that of current military CMI instructors. A final report will describe the results of an in-service training program designed to teach instructors how to perform the activities entailed in the ideal role, and will serve as an operational test of the ideal role model.

The technical monitor was Dr. Kathleen A. Lockhart.

RICHARD C. SORENSON
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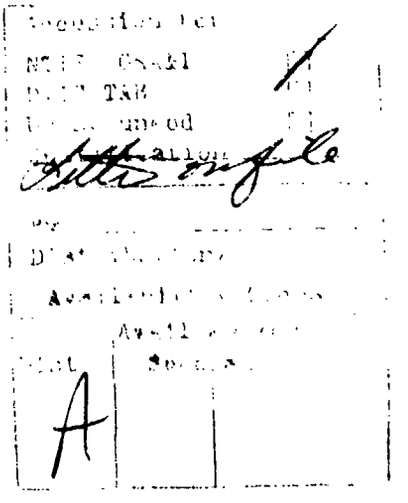

## SUMMARY

### Problem

The unique demands of a computer-managed instruction (CMI) system require the development of instructor roles and functions that are tailored to this environment. While there are several large-scale CMI systems currently operating both in the military and civilian worlds, there has been no systematic attempt to analyze this training environment and to design a set of behaviors for the CMI instructor. Specification of optimal instructor roles and the development of training programs to teach the requisite skills should significantly increase the effectiveness of the CMI instructor.

### Purpose

This report summarizes the results of literature reviewed in the areas of (1) relevant theoretical frameworks for defining ideal CMI instructor roles, and (2) existing CMI system functions and definitions of CMI instructor roles. Also, it outlines a format for the Theoretical CMI Instructor Role Specification that will be used to identify specific instructor behaviors within each role and to assess deviations of the ideal from actual CMI instructor behaviors in selected military CMI environments.

### Approach

1. Theoretical frameworks of relevance to the definition of ideal CMI instructor roles were identified as being based on operant learning principles and principles derived from a cognitive theoretical framework.

2. Seven CMI systems were reviewed: The classroom information system (CIS), the Navy CMI system, the Air Force Advanced Instructional System (AIS), the Program for Learning in Accordance with Needs (PLAN), the TRACER system, the Instruction Support System (ISS), and the PLATO CMI system. A systems engineering analysis approach was taken to identify those computer-based functions that directly support student learning in a CMI environment. Finally, CMI systems were evaluated to determine whether they performed these functions.

3. Recent studies made from the perspective of both manual self-paced (MSP) environments and CMI environments were reviewed to identify and define CMI instructor roles.

Results

1. Two primary instructor roles were identified—Learning Manager and Learning Facilitator. Within the Learning Manager role are the roles of Planner of Classroom Operation and Plan Implementation/Monitor of Student Performance and Progress. Within the Learning Facilitator role are the roles of (a) Evaluator of Individual Student Performance and Provider of Motivational Performance Feedback, (b) Diagnostician of Individual Student Learning Problems, (c) Counselor and Advisor of Students as to Appropriate Learning Strategies, (d) Remediator of Student Learning Problems by Prescription or Administration of Selected Strategies and Resources, and (e) Tutor/Modeler of New Information, Skills, and Personal Responsibility.

2. Five major categories of functions were identified as directly supporting student learning in a CMI environment. Diagnosis, Prescription, Performance Evaluation, Reporting, and Flexible Scheduling. A majority of the seven CMI systems evaluated (a) perform precourse and within-course diagnostic assessment of student characteristics and performance; (b) prescribe at least individualized student assignments and often individualized course placement, progress management, and remediation and counseling; (c) provide performance evaluation of various student behaviors; and (d) report both course and student performance indices. Flexible scheduling capabilities were not supported by a majority of the CMI systems reviewed.

3. Ten instructor roles were identified as being facilitative of effective student learning in these educational settings. Within these ten roles, the major roles of instructors were seen to be those of Counselor/Advisor, Learning Strategies Expert, and Tutor/Counselor. Secondary roles were seen to be those of Evaluator, Prescriber, and Resource Manager; and third priority roles were seen to be those of Administrator,

Classroom Manager, Diagnostician, and Technical Expert. All but the Technical Expert role identifed in this area of the literature review were generally subsumed under the primary theoretical roles of Learning Manager and Learning Facilitator.

4. A general format for the Theoretical CMI Instructor Role Specification is presented, which allows for a tabular listing of the seven theoretically-based CMI instructor roles, the instructor behaviors associated with each role, as well as spaces for annotating the extent to which actual CMI instructor roles and behaviors deviate from the theoretically-based roles in the military CMI environments of interest.

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# INTRODUCTION

## Problem

The unique demands of a computer-managed instruction (CMI) system require the development of instructor roles and functions that are tailored to this environment. While there are several large-scale CMI systems currently operating both in the military and civilian worlds, there has been no systematic attempt to analyze this training environment and to design a set of behaviors for the CMI instructor. Specification of optimal instructor roles and the development of training programs to teach the requisite skills should significantly increase the effectiveness of the CMI instructor.

## Purpose

This interim technical report for the CMI Instructor Role Definition and Training project summarizes the results of literature reviewed in the areas of (1) relevant theoretical frameworks for defining ideal CMI instructor roles, and (2) existing CMI system functions and definitions of CMI instructor roles. Also, it outlines a format for the Theoretical CMI Instructor Role Specification that will be used to identify specific instructor behaviors within each role and to assess deviations of the ideal from actual CMI instructor behaviors in selected military CMI environments.

The goals of the literature review were to identify information relevant to a generalized concept of ideal CMI instructor roles, while at the same time bearing in mind distinct differences in the training environments and procedures of military versus civilian CMI applications. For example, although relevant literature might suggest that CMI instructors should be engaged in deciding what is to be taught in a subject area and in planning how the instructional system should be set up to best manage selected instructional procedures--there is substantially less flexibility in military systems, as compared to civilian systems, for instructors to make these kinds of curriculum decisions. In the military, course objectives and the means to achieve these objectives are well-specified, leaving the instructor with a narrower range of decision-making in this regard.

Thus, whenever it was known that such factors limited the concept of ideal CMI instructor roles for this contract's military application, they were taken into account in the final derivation of theoretically-based CMI instructor roles.

It should be noted that, in deriving the Ideal CMI Instructor Role Model, three sources of information were integrated: (1) the implications for CMI instructor roles that can be derived from relevant instructional and learning theories, (2) the review of what instructional functions existing CMI systems are generally performing, and (3) the review of what roles CMI instructors are currently performing or roles discussed by various authors. The word "ideal," then, reflects this synthesis and can be interpreted as meaning those characteristics that a majority of the systems or instructors are presently performing.

Scope

The first section of this report presents the basis for selecting particular theoretical frameworks of relevance to the definition of the ideal CMI instructor role model, derives implications from these theoretical frameworks for the CMI instructor role model, and synthesizes implications from various theoretical frameworks.

The next section presents a conception of ideal CMI system functions, derived from literature in the areas of existing large-scale CMI systems and current conceptions of the role of instructor in these systems. Existing CMI system functions and conceptions of CMI instructor roles are compared for the purpose of extracting those functions and roles generally agreed to be "ideal," and this "ideal" is then compared with the list of theoretically-based CMI instructor roles. In addition, an explicit statement of the assumptions underlying the student's role in the ideal CMI system is presented.

Finally, in the last section, the purpose and requirements of the Theoretical CMI Instructor Role Specification are discussed, and the general format of this role specification is presented. This section closes with a brief discussion of the next step in the CMI Instructor Role Definition and Training project--that of specifying instructor behaviors

within each role identified in this report, and evaluating the relative contribution of these behaviors to student learning.

## THEORETICAL RATIONALE FOR IDEAL CMI INSTRUCTOR ROLE MODEL

### Theoretical Frameworks of Relevance

In determining those learning or instructional theory frameworks of relevance to the derivation of an Ideal CMI Instructor Role Model, it is instructive to briefly trace the historical and theoretical frameworks underpinning computer-managed instruction. A major impetus for the development of CMI systems can be traced to earlier efforts (circa 1950 through 1965) to meet individual student learning needs by programmed instruction (PI) and, later, computer-assisted instruction (CAI) approaches. These approaches were, in large part, based on principles from Skinner's (1953, 1958, 1961, 1968) reinforcement or operant learning framework, other behavioral approaches (e.g., Crowder, 1960), and on advances in instructional and computer technologies. Within this framework, the emphasis was on engineering the students' environment by arranging external reinforcements and instructional contingencies such that maximum learning would be expected. The limited individualization possible with PI and the high costs originally associated with CAI, however, were major factors responsible for a shift in emphasis to CMI as a more cost-effective approach to large scale individualization.

In the decade or more since CMI systems have been adopted to meet individual student learning needs in both civilian and military applications, the focus has been on providing system capabilities, instructional materials, and computer-based procedures to enhance individual student learning--with little or no attention being given to the role of the instructor in CMI systems. Although it has been recognized that the student's role is shifting from a passive to an active learner, questions as to what this meant for the role of the instructor, how the instructor could best facilitate student learning in a CMI environment, etc. have remained virtually unanswered. Although CMI instructors have

been trained in the mechanical aspects of their CMI role (e.g., what the computer does, how they can interact with the computer to perform various management functions), a clear, integrated specification of their roles as learning facilitators and the theoretical basis for these roles has not been accomplished. (Obviously, as discussed in the next section, numerous individuals have discussed CMI instructor roles from a variety of perspectives, and proponents of individualized instruction have addressed the issue from selected theoretical frameworks. There have been no systematic attempts, however, to specify an integrated theoretical rationale for these CMI instructor roles).

Given the lack of a well-specified theoretical rationale for the learning facilitator roles of a CMI instructor, this section is devoted to setting forth implications for CMI isntructor roles that can be derived from contemporary learning theories. Contemporary theories of relevance to the individualized instructional philosophy underlying CMI include principles from an operant learning framework and recent theoretical advances in the field of cognitive psychology. Operant learning principles are relevant since they form the basis for defining the external or situational factors necessary for effective learning; and cognitive learning theories, since they form the basis for defining the internal or learner factors that contribute to effective learning. The following sections, therefore, will first discuss those implications for CMI instructor roles that can be derived from operant learning principles, followed by a discussion of implications for CMI instructor roles that can be derived from a cognitive theoretical framework. A synthesis of these two theoretical bases will be provided in the form of a summary of theoretically-based CMI instructor roles and concomitant assumptions about the student's role in CMI will be discussed.

## Implications of Operant Learning Principles for CMI Instructor Roles

The advent of programmed instruction marked one of the first applications of laboratory results from experiments on operant conditioning, reinforcement, discrimination, and behavior shaping to the problem of human learning (Drekman, 1968). The four basic principles of learning incorporated into the programming of instructional materials (Dick, 1965) are listed below:

1. The materials should be designed to present the subject matter in small bits or steps to the student.

2. The materials should require the student to actively respond to the subject matter by constructing or selecting answers to questions over each step.

3. The student should receive immediate feedback (or reinforcement) in the form of information about the quality of his response.

4. The student should continue at his or her own rate or pace through the instructional program.

The basic assumption was that the student was actively involved in the learning process. Thus, the emphasis shifted such that the entity primarily reponsible for imparting knowledge to the student became the instructional materials and programming methods rather than the instructor. If the student failed, it was the fault of the instructional material--not the teacher and not necessarily the student.

Given that the instructor's role in this new "programmed" learning environment no longer incorporated the function of information dispenser, the question becomes one of determining what proponents of operant learning theory have to say about the new instructor role. Skinner (1968) addressed the problem of teacher role in these "programmed" learning environments in a general fashion. His position was that the learning environment should be set up with appropriate contingencies and reinforcements to allow learners to gain genuine competence. Within this environment, he felt that the most important teacher functions are in the area of providing the distinctively human intellectual, cultural, and emotional contacts that cannot be provided by machines. That is, Skinner assigned the mechanizable functions of instruction to machines and left the teacher with the responsibility for arranging the reinforcement contingencies necessary for learning. To perform this role, Skinner felt the teacher should be a specialist in human behavior--a specialist in bringing about desired behavior change through appropriate changes in the instructional materials or procedures (contingencies) used in the classroom.

In expanding operant learning theory principles to a total classroom environment, Keller (1966, 1968) addressed the role of the instructor more explicitly. In his concept of the Personalized System of Instruction (PSI), Keller added the following to the four learning principles underlying programmed instruction:

1. Telling the students what they are expected to learn by a statement of course and unit objectives.

2. Requiring restudy and repeated testing until the students achieve unit mastery.

3. Criterion-referenced evaluation of accomplishments.

4. Using student proctors as tutors to enhance the personal-social aspects of education.

5. Using lectures and demonstrations as vehicles of motivation rather than as sources of critical information.

Within this PSI environment, then, the instructor's role becomes one of educational engineer, contingency manager, and facilitator of learning in others (Keller, 1968). The instructor determines what is to be taught, how, and to what degree. Proctors in the PSI system are delegated a variety of tasks ranging from administrative to clerical to tutorial (e.g., monitoring student progress, scoring achievement tests, performing remediation).

Since PSI represents a broad-based attempt to apply operant learning principles to the total learning experience, it is of interest to examine what others who advocate this type of approach have to say about the instructor's role. Johnston and Pennypacker (1971) describe a behavioral approach to teaching undergraduate college courses that included operant learning principles of self-pacing, immediate student and teacher feedback, a minimum behavioral performance criterion on each instructional unit, specification of course objectives and goals in terms of directly observable student behavior, continuous recording of student progress, and the use of students as teachers. In discussing the teacher's role within this learning system, Johnston and Pennypacker state that the use of student managers leaves the instructor free to select both how much and what kind of

student involvement should be incorporated into the course, to determine how lectures are to be used, and to be generally responsible for planning the conduct of the course.

Wilson and Tosti (1972) also worked within an operant framework and under the assumption that the learning system is student-centered and should be as responsive to individual student needs as possible. They describe three general areas of teacher responsibility: (1) preparation (selecting study materials, organizing presentation of materials, planning student activities), (2) administration (presenting or arranging presentation of learning experiences, monitoring and recording student progress, evaluationg student achievement), and (3) instructional management (taking a meaningful part in the guidance of students). It is this role of instructional manager which Wilson and Tosti consider the most important and satisfying to most teachers.

In the operant learning framework, the instructional manager can delegate the functions of assessment, decision, and activation of learning experiences to a computer, proctors, or the students themselves. This leaves the instructional manager with responsibilities for deciding precisely what student behavior is desired, systematically controlling the consequences of that behavior, ranking the desirability of alternative consequences from a student's perspective, and making the most desirable consequences contingent on the desired behavior (Wilson & Tosti, 1972). Thus, within the operant framework, the primary role of the instructor in the learning process is one of arranging and controlling external contingencies such that the desired student learning takes place (e.g., Johnston & Pennypacker, 1971; Keller, 1968; Skinner, 1968; Wilson & Tosti, 1972). A secondary role is one of providing tutoring guidance, and more frequent and better informed advice to the students (e.g., Terman, Barkmeier, & Cook, 1979; Wilson & Tosti, 1972).

That a behavioral approach to instruction (i.e., numerous PSI evaluations) can lead to effective learning as compared with traditional teaching methods, at least at the college level, has been summarized and documented in a recent meta-analysis by Kulik, Kulik, and

Cohen (1979). Although this finding lends empirical support to the efficiency of the instructional procedures, practices, and assumptions--including the role delegated to instructors--in that type of behaviorally-oriented system, it tells us nothing about the role of the CMI instructor.

We know that the computer can perform many of the diagnostic, prescriptive, evaluative, administrative, and contingency management functions that might be included in the instructor's role in a PSI or behavioral learning system. In addition, in military CMI systems, even further restrictions are necessary to the instructor's role that emerges from an operant framework. That is, in military CMI systems, the instructors may or may not have much flexibility in planning how a subject matter is to be taught. From an operant framework, then, keeping in mind the constraints of military technical training, it would appear that the CMI instructor's role should include the following functions (or subroles):

1. Decision-making about appropriate instructional activities and reinforcement contingencies.

2. Monitoring student performance and progress, supplying appropriate individual performance feedback.

3. Engaging in individual student tutoring and guidance when learning problems arise.

4. Advising students about subject-matter related sources of information not available in the curriculum, in both individual and group sessions.

Implications of Cognitive Theories for CMI Instructor Roles

Just as Skinner has been credited with the first systematic formulation of operant learning principles, Wittrock can be credited with systematically extracting and formulating those principles derived from cognitive psychology that have relevance for instructional practice (Wittrock, 1978, 1979; Wittrock & Lumsdaine, 1977). Many of these principles also have implications for the role of an instructor in a learning environment in which the student is held responsible for his or her own learning (e.g., a CMI environment).

One of the basic assumptions of cognitive psychologists regarding learning can be seen to be in direct opposition to certain operant learning principles. For example, Wittrock & Lumsdaine (1977) point out that current cognitive approaches emphasize that a student learns by actively changing perceptions, thus constructing new meanings and interpretations--and that learning can occur without practice or reinforcement. In addition, cognitive theorists maintain that learning from instruction is an internal, cognitively mediated process--and not a direct product of the environment, people or other external factors (Wittrock, 1978).

Cognitive theorists also assume that cognition is the key to understanding behavior and that thoughts lead to action (Cohen, Emrich, & deCharms, 1976-77). It seems clear, therefore, that cognitive theorists--while not disagreeing with the operant theorists that the learner is active--have expanded the definition of active learning and have shifted the locus of responsibility for this activity from outside (external reinforcement contingencies) to inside the learner (internal cognitive processes, motivations, belief systems). The concept of reinforcement also changes within a cognitive framework, and is seen as depending on perceived informational and affective qualities for its effect, as well as on whether students see reinforcements as being related to their effort, ability, or luck (Wittrock & Lumsdaine, 1977).

Major research areas that have contributed to cognitive theory include research in attributional processes, locus of control, cognitive processes, and cognitive reinterpretations of reinforcement theory (Wittrock & Lumsdaine, 1977). From the areas of attribution and locus of control (motivation) research, a new concept of the factors that help define the "ideal" student are emerging. The student is seen as responsible and accountable for his or her own learning; further, it is recognized that there are large individual differences in students' ability to take on this new role. Efforts to train students to change their attitudes toward locus of responsibility and teaching them that they cause their behavior and can influence future behaviors has been highly successful in

increasing student learning--without changing curricula (e.g., Cohen et. al., 1976-77; deCharms, 1972, 1976). Students can also be trained to attribute both success and failure to effort (an unstable internal cause), which results in their increased perseverance, success, positive emotional reactions, and increased self esteem (Wittrock, 1979). All of these findings support the validity of the cognitive model of the learner, and add to an understanding of the characteristics of effective learner.

From the field of cognitive psychology and the study of cognitive processes comes the recognition that people mentally construct the reality in which they live (Wittrock, 1979). What this principle means for learning is that students differ in the realities they construct or generate, that they use different mental processes, and that different learning strategies are effective for different learners. Compensation for these differences is thus required via differential skill training or alternative kinds of instructional treatments. The learner is then responsible for attending to the instruction and for actively constructing the mental elaborations that make learning personally meaningful. The ideal instructional process, then, is one that begins with a diagnosis of the cognitive and affective processes and aptitudes of the learner, followed by assignment to individualized treatment (Wittrock, 1978).

From the field of cognitive-behavioral models and cognitive reinterpretations of reinforcement theory comes the "marriage" of traditional (mentalistic) and behavioral theoretical frameworks (Kendall & Hollon, 1979). Along with this marriage comes the recognition that self-talk or cognitive dialogues play an important part in learning, and that students can be taught the executive processes and cognitive-behavioral procedures for effective learning (Meichenbaum & Asarnow, 1979). Thus, within this cognitive-behavioral framework, validity is given to unobservable mentalistic processes and to observable behavior. The validity of phenomenological data (client report) is accepted along with the validity of externally defined criteria.

What can these cognitive theoretical perspectives tell us about the role of an instructor in an ideal learning environment that is adaptive to individual student learning

needs and where the student is reponsible for his or her own learning—such as a CMI environment? Wittrock and Lumsdaine (1977) discuss the fact that instructors' roles change (1) if they perceive that they are responsible for changing the student's inappropriate attributions of success or failure and locus of responsibility, and (2) when they recognize their role in helping the learner to selectively attend to the information to be learned and to construct meaning from it. The instructor's role in the facilitation of learning includes the functions of directly (through tutorial experiences) and indirectly (through behavior modeling) influencing what students believe and think, as well as how they go about meaningfully integrating new information. As Wittrock (1978) has pointed out, teachers need to be aware and sensitive to probing the student about both his or her cognitive processes and content. They can then go about the job of facilitating attention, attributional processes, use of relevant learning strategies, generation and active construction of inferences and elaborations--using a variety of strategies, media, and methods to accomplish this learner facilitator role.

Additional implications for the CMI instructor role that can be drawn from the cognitive theoretical framework include the suggestions that teachers need to be aware that they are responsible for positively influencing the cognitive and motivational processes used by the students. They need to be taught that they have a positive influence on student learning outcomes by such characteristics as openness, complexity, interpersonal sensitivity, and the preference for a flexible approach to learning--all of which emphasize principles of relativity and a problem-solving approach (Cohen et. al., 1976-77). Further, they need to be taught such skills as estimating task difficulty, self-interrogation, self-testing, monitoring the use of a strategy, adjusting the strategy to task demands, and making use of implicit and explicit feedback--all of which can be translated into teachable self-statements (Meichenbaum & Asarnow, 1979).

The cognitive theoretical framework, then, suggests that the CMI instructor's role should include the following functions or subroles:

1. Modifying, as necessary, students' inappropriate attributions and perceptions about locus of responsibility for learning.

2. Counseling and advising students about appropriate strategies for attending to new information and for constructing meaning from it.

3. Diagnosing internal sources of students' learning problems, including their use of appropriate cognitive processes, learning strategies, motivational processes and self-statements.

4. Decision-making about appropriate remediation activities, strategies, and resources that are matched to students' learning needs.

5. Modeling the practical use of new information and skills and the concept of personal responsibility, through individual and group tutorial sessions.

Assumptions About the Student's Role in CMI

The theoretical frameworks selected as a basis for defining CMI instructor roles also had something to say about the role of the student in a CMI environment. The basic assumption within this type of learning environment is that the student is responsible for his or her own learning. Given that this assumption has implications for what instructors are taught about their CMI instructor roles, this section summarizes some of the specific areas for which students are expected to be responsible.

1. Students are expected to be attentive and motivated.

2. Students are expected to make learning meaningful by the appropriate use of learning strategies and skills.

3. Students are expected to practice personal responsibility skills required for self-initiated learning, self-directed learning, and self-paced learning.

4. Students are expected to interact effectively with both their peers and their instructors.

5. Students are expected to set appropriate course and life goals.

To the extent that students having learning problems in a CMI environment are unable to effectively exercise the above responsibilities, the CMI instructor is going to be

required to thoroughly understand the various learning strategies that will facilitate students' increase in personal responsibility. Thus, within the Learning Facilitator CMI Instructor Role, a major training components would surely include familiarizing instructors with the kinds of cognitive, attentional, and motivational processes and strategies that are associated with effective, responsible student learning.

Summary of Theoretical CMI Instructor Roles

The purpose of this section is to integrate the results of the analysis of CMI instructor roles from an operant learning theory framework and from the perspective of current cognitive theories. This synthesized listing of derived instructor roles appropriate to a CMI learning environment will be compared and contrasted with those roles that emerge from the review of current CMI instructor role definitions in the next section (p. 31).

In examining the CMI instructor roles derived from both the operant and cognitive learning theory frameworks, theoretically-based CMI instructor roles can be said to include the following:

1. Planning the overall operation of the classroom (or learning center), including decisions about appropriate rewards, placement and frequency of group and individual activities, types of adaptive remediation strategies to be used in conjunction with available computer-based remediation procedures, and how lectures should be used.

2. Implementing instructional plans via CMI and monitoring student performance and progress by frequent use of classroom observation, computer-supported reports, or data examination and extraction capabilities.

3. Making appropriate individual performance evaluations and providing personal motivational performance feedback to individual students.

4. Diagnosing internal sources of learning problems for those students having difficulty achieving performance criteria, including diagnosing their use of appropriate cognitive processes, learning strategies, motivational processes, and self-statements.

5. Counseling and advising students about their individual learning problems and appropriate strategies (both cognitive and affective) for dealing with these problems.

6. Remediating student learning problems by selecting, prescribing, or administering various individualized strategies judged to be appropriate solutions to the particular learning problems.

7. Modeling the practical use of new knowledge and skills, along with the concept of personal responsibility, and including all tutorial experiences (individual and group).

The seven CMI instructor roles identified here can be categorized into those roles that are primarily concerned with learning management, and/or the facilitation of learning. The Learning Manager Role can be thought of as including those activities that involve the overall planning and implementing of the learning process for all students in the CMI environment. The Learning Facilitator Role, on the other hand, can be thought of as involving those activities directed at facilitating the performance of individual students in the CMI environment--particularly those students with learning problems. Therefore, the categorization of theoretically-based CMI instructor roles shown in Figure 1 is suggested.

I. Learning Manager

A. Planner of Classroom Operation

B. Implementor of CMI Plans and Monitor of Student Performance and Progress

II. Learning Facilitator

A. Evaluator of Individual Student Performance and Provider of Motivational Performance Feedback

B. Diagnostician of Individual Student Learning Problems

C. Counselor and Advisor of Students as to Appropriate Learning Strategies

D. Remediator of Student Learning Problems by Prescription or Administration of Selected Strategies and Resources

E. Tutor/Modeler of New Information, Skills, and Personal Responsibility

Figure 1. Theoretically-based CMI Instructor Roles.

## CURRENT CMI SYSTEM FUNCTIONS

The purposes of this section are to identify the general functions that major CMI systems are currently performing, derive those functions considered to be "ideal," and to review those roles that are currently being defined as appropriate for the CMI instructor.

Review of Existing Systems and Derivation of Functions

The CMI systems selected for this review are:

1. The classroom information system (CIS), which is part of the individually prescribed instruction (IPI) and Primary Education Project (PEP) at the University of Pittsburgh (Wang, 1975, 1976; Wang and Fitzhugh, 1977).

2. The Navy CMI system (Bozeman, 1979; Johnson & Mayo, 1974; Kerr, 1978; Kerr & Harrison, 1979; McMichael, Brock, & DeLong, 1976; Middleton, Papetti, & Micheli, 1974; Van Matre & Chambers, 1979).

3. The Air Force Advanced Instructional System (AIS) (Judd & Klem, 1979; Lintz, Tate, Pflasterer, Nix, Klem, & Click, 1979; McCombs, 1979; Rockway & Yasutake, 1974; Yasutake, 1974).

4. The Program for Learning in Accordance with Needs (PLAN) developed by the American Institute for Research and Westinghouse Learning Corporation (Baker, 1971; Bozeman, 1979; Dehart, 1974; Westinghouse Learning Corporation, 1973).

5. TRACER, a CMI system commercially available through CTB/McGraw-Hill (Baylor, 1979; Bozeman, 1979).

6. The Instruction Support System (ISS) developed at Pennsylvania State University (Countermine & Singh, 1974; Mitzel, 1974; Subcommittee on Domestic and International Scientific Planning, Analysis and Cooperation, 1978a, 1978b).

7. The PLATO CMI system commercially available through the Control Data Corporation (CDC) (Cain, 1979; CDC, 1978a, 1978b, 1979).

Several criteria were used in the selection of these seven CMI systems. First, these systems are all large-scale, operational CMI systems being used in applied civilian or

military settings. Second, the mastery learning concept is the instructional philosophy being implemented by all seven CMI systems. Additionally, these systems have been investigated to the extent that sufficient documentation was available for objectively reviewing their functions. Finally, conversations with numerous computer-based system experts (R. Filinger, Air Force Human Resourses Laboratory, Technical Training Division, Lowry AFB; J. D. Fletcher, Defense Advanced Research Projects Agency, Cybernetics Technology Office; W. A. Judd, McDonnell Douglas Astronautics Company, AIS Lowry AFB Unit; H. F. O'Neil, Jr., Army Research Institute, Computer-Based Training Technology; D. B. Thomas, CAI Laboratory, University of Iowa; M. C. Wang, Learning Research and Development Center, University of Pittsburgh) indicated that these were the systems that were most comprehensive in terms of the functions they performed and the most effective in their particular applications.

A systems engineering analysis approach was taken to identify those computer-based functions that directly support student learning in a CMI environment. That is, each of the numerous CMI functions described in the literature (Baker, 1971; Dennis, 1979; Dick & Dodl, 1970; Glaser, 1969; Hansen, Merrill, Kropp, & Johnson, 1971; Lintz et al., 1979; Rockway & Yasutake, 1974) was analyzed in terms of whether it directly contributed to the students' learning process. Functional capabilities that were more strictly administrative (e.g., data extraction and analysis capabilities) or supportive of the presentation of instruction (e.g., authoring support capabilities, CAI capabilities) were not included. The selected computer-based functions were then classified into five major categories generally agreed to be important for student learning in CMI environments: diagnosis, prescription, performance evaluation, reporting, and flexible scheduling. These five functions and their concomitant subfunctions are described in the following paragraphs.

1. DIAGNOSIS.

a. Precourse assessment refers to computer-based support of student characteristic diagnosis at the beginning of a course, such that these data are available for various types of individualization decisions during the course. This functional capability provides for the assessment of such information as students' (1) entry skills with respect to the knowledge and performance of course objectives, (2) general abilities and skills, (3) course-specific abilities, (4) general motivation, interests, and learning styles, (5) course-specific motivation and personality variables relevant to the course, (6) study habits and skills, as well as relevant learning strategies, and (7) background and biographical variables such as relevant prior experiences and skills.

b. Within-course assessment is the capability to assess such student characteristics as (1) changing interests and motivation, (2) changing learning styles and media preferences, (3) mastery levels on first and subsequent testing attempts, (4) times-to-mastery or criterion, and (5) failure and progress rates.

In general, then, the Diagnosis category includes those computer-based capabilities for measuring and evaluating a student's characteristics and changing performance variables.

2. PRESCRIPTION. This function includes computer-based capabilities for individualizing various course curricula or procedures via decision-making strategies, such that a match is provided between individualization strategies and student characteristics.

a. Individualized course placement capabilities provide for (1) students to be assigned to different course versions or different sequences of course materials based on their specific characteristics or learning needs, and (2) advanced placement of individuals who have exhibited some or all of the prerequisite skills during diagnostic testing.

b. Individualized progress management may support either externally- or internally-defined progress goals. Externally-defined progress goals are those that are determined by the system or an instructor based on individual difference data; and

internally-defined goals, those that are determined by individual students based on their judgments.

c. Individualized student assignment is a computer-based prescriptive capability that attempts to match individual students with different strategies, media, or course material treatments to maximize a student's course progress or performance. These individualized prescriptions can be the result of computer-based decision rules (e.g., heuristic models, regression equations) or the system may provide for the selection of alternatives by the instructor or individual student (learner control capability).

d. Individualized remediation and counseling refers to those computer-based prescriptions that attempt to match students who are having difficulty with the course with alternative remediation materials, strategies, or counseling approaches. That is, the computer may be used to prescribe more drill and practice, the assistance of an instructor or a tutor, or a peer counseling session.

3. PERFORMANCE EVALUATION. This function provides for the evaluation of students, instructors, or both--as well as for the evaluation of individuals or groups.

a. Instructor evaluation may be provided in terms of student grades, student time or progress in the course, failure rates, effective remediation, or numerous other criteria.

b. Student evaluation may be provided in terms of (1) the amount of time students have been enrolled in the course relative to some group or individual criteria, and/or (2) criterion test performance. Test performance evaluation may be in the form of percentage correct, objectives passed or failed, or simple pass/fail decisions.

4. REPORTING. This function includes the capability of recording, analyzing, and reporting information on four aspects of the system: The curriculum (course performance), the instructors, the resource inventory, and the students.

a. Course performance reports provide quality control information in the form of computer-generated course and test item evaluation summaries.

b. Instructor performance reports can include summaries of various instructor performance indices (individual or group), particularly as these may relate to student course performance.

c. Resource inventory reporting is a computer-based administrative procedure that tracks various resources such as test forms and media equipment, and notes when replacement orders or preventive maintenance are required.

d. Student performance reporting includes the capability of providing performance feedback to students (usually in the form of student prescriptions), or providing student performance (individual or group) reports to instructors for monitoring or counseling purposes.

5. FLEXIBLE SCHEDULING. This function refers to those computer-based capabilities that provide flexibility in the scheduling of students, instructors, or instructional content and resources in unusual or idiosyncratic situations. That is, the capability that allows instructors to better adapt instructional parameters to unique student needs.

a. Scheduling of the course format provides for the computer-supported organization of individual or group activities, thereby contributing to the ability of the system and the instructor to track and adapt to the needs and requirements of all aspects of the system.

b. Scheduling of course sequencing strategies allows for the system and/or the instructor and/or the student to design various patterns or pathways for completing course materials when unusual situations occur that are outside available computer-based options.

c. Scheduling of instructor-student interactions provides a means for instructors to schedule an instructor-student session whenever a special need (e.g., a test failure) arises.

d. Scheduling of instructional resources refers to the capability of instructors to modify information on resource availability, location, or even the selection of particular student/resource matches.

e. Scheduling of student progress management allows instructors to change parameters affecting a student's predicted completion times or to change targeted times themselves.

f. Flexible scheduling of student-student interactions refers to the capability to, for example, designate efficient or effective students as peer tutors and to schedule them for special sessions with students who are having difficulty in the course--at a time that is appropriate for both students. It can also take the form of a "buddy system" wherein students who have certain characteristics (such as orders to the same base) can be brought together to form an informal support system.

Table 1 (1) lists the major CMI systems currently operating within a mastery learning framework, (2) identifies the various computer-based functions of these systems that support effective student learning, (3) compares and contrasts the functional capabilities of each of these systems, and (4) determines the functions that are performed by the majority of the selected CMI systems and those that are performed by few systems. This latter information is summarized below.

1. The CIS (a) provides for assessment of precourse characteristics and within-course performance, (b) prescribes individualized course placement and student assignments, and (c) supports the reporting of student performance such that teachers use the computer to retrieve student performance histories to assist them in writing individual student prescriptions (Wang, 1975, 1976; Wang & Fitzhugh, 1977).

2. The Navy CMI system (a) provides for assessment of precourse characteristics and within-course performance, (b) prescribes individualized course placement, progress management, student assignment, and remediation and counseling, (c) supports performance evaluation of students, and (d) provides reports on course and student performance (Bozeman, 1979; Johnson & Mayo, 1974; Kerr, 1978; Kerr & Harrison, 1979; McMichael et al., 1976; Middleton et al., 1974; Van Matre & Chambers, 1979).

Table 1

Computer-Based Functions of Selected CMI Systems

| SELECTED CMI SYSTEMS | Functional Capabilities | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Diagnosis | | Prescription | | | | Performance Evaluation | | Reporting | | | | Flexible Scheduling of | | | | | |
| | Precourse Characteristics | Within-Course Performance | Individualized Course Placement | Individualized Progress Mgt. | Individualized St. Assignment | Individualized Remediation/Counseling | Instructor Eval. | Student Eval. | Course Performance | Instructor Performance | Resource Inventory | Student Performance | Course Format | Course Sequencing | Instructor-Student Interactions | Instructional Resources | Student Progress Management | Student-Student Interactions |
| CIS | X | X | X | — | X | — | — | — | — | — | — | X | — | — | — | — | — | — |
| Navy CMI | X | X | X | X | X | X | — | X | X | — | — | X | — | — | — | — | — | — |
| AIS | X | X | X | X | X | X | — | X | X | — | — | X | X | X | X | X | X | — |
| PLAN | X | X | X | X | X | — | — | X | — | — | X | X | — | X | — | — | — | — |
| TRACER | X | X | — | X | — | X | — | X | X | — | — | X | — | — | — | — | X | — |
| ISS | — | — | — | — | X | — | — | X | — | — | — | X | — | — | — | — | — | — |
| PLATO CMI | X | X | X | — | X | X | — | X | X | — | — | X | — | X | X | — | — | — |
| SUMMARY | 6/7[a] | 6/7[a] | 5/7[a] | 4/7[a] | 6/7[a] | 4/7[a] | 0/7 | 6/7[a] | 4/7[a] | 0/7 | 1/7 | 7/7[a] | 1/7 | 3/7 | 2/7 | 1/7 | 2/7 | 0/7 |

[a]Functions performed by majority of CMI systems reviewed.

3. The AIS (a) provides for assessment of precourse characteristics and within-course performance, (b) prescribes individualized course placement, progress management, student assignment, and remediation and counseling, (c) supports student performance evaluation, (d) provides reports on course and student evaluation, and (e) performs scheduling of course format, course sequencing strategies, instructor-student interactions, resource managment, and student progress management (Judd & Klem. 1979; Lintz et al., 1979; McCombs, 1979).

4. PLAN (a) provides for assessment of precourse characteristics and within-course performance, (b) prescribes individualized course placement, progress management, and student assignments, (c) evaluates student performance, (d) provides reports on resource inventory and student performance, and (e) performs flexible course sequencing strategies (Baker, 1971; Bozeman, 1979; DeHart, 1974; Westinghouse Learning Corporation, 1973). It should be noted that PLAN is the only system having the ability to report the status of various instructional materials and resources (e.g., current supply of forms or number of times the equipment has been used).

5. The TRACER system (a) provides precourse and within-course diagnosis, (b) prescribes individualized progress managment and remediation counseling, (c) evaluates student performance, (d) provides reports on course and student performance, and (e) schedules student progress management variables (Baylor, 1979; Bozeman, 1979).

6. The ISS system prescribes individualized student assignment, and evaluates and reports on various student performance indices (Countermine & Singh, 1974; Mitzel, 1974; Subcommittee on Domestic and International Scientific Planning, Analysis and Cooperation, 1978a, 1978b).

7. The PLATO CMI system (a) provides for precourse and within-course diagnosis, (b) prescribes individualized course placement, student assignments, and remediation counseling, (c) evaluates student performance, (d) provides reports on course and student

performance, and (e) provides for flexible scheduling of course sequence and instructor-student interactions (Cain, 1979; CDC, 1978a, 1978b, 1979).

The bottom row of Table 1 summarizes the number of systems performing the selective instructional functions.

In summary, based on this analysis of CMI functions performed by the selected CMI systems, the following functions can be considered to be "ideal" from the standpoint of being performed by the majority of systems:

1. Diagnosis--both precourse and within-course assessment of student characteristics and performance.

2. Presecription of individualized student assignments, individualized course placement, progress management, and remediation and counseling.

3. Performance evaluation of various student behaviors.

4. Reporting of both course and student performance indices.

It should be noted that those instructional functions that are not being performed by the majority of the CMI systems reviewed were also identified as being important for effective student learning. Moreover, in those CMI systems that did not provide computer support for these remaining instructional functions--particularly in the flexible scheduling category--instructors or other course personnel generally assumed the responsibility for performing these functions. For example, if the computer is not performing flexible scheduling, the instructor must be aware of idiosyncratic student needs that might require him to (1) find ways to flexibly group students for instructional purposes, (2) flexibly resequence portions of the course for some students, (3) set up flexible schedules for individual interactions with particular students, (4) flexibly assign instructional resources, (5) set up flexible student progress management conditions or rules, or (6) set up flexible procedures for students to interact with each other. Also, if the system does not provide support for individual instructor evaluations and reports, instructors should find ways to monitor and record their own performance. Thus, it appears that CMI instructors must

enhance the individualization technology of the computer by performing those diagnostic, prescriptive, evaluative, reporting, and scheduling functions which the computer does not support. Further implications for CMI instructor roles are derived from the review of how various persons involved with self-paced and/or individualized instruction have defined these roles, as presented in the following section.

Review of Current CMI Instructor Role Definitions

The purpose of this section is to review the work of those individuals who have discussed the role of the instructor in self-paced and/or individualized instructional environments. That is, this section will summarize the literature on instructional roles facilitative of student learning in both manual self-paced (MSP) and computer-managed instructional (CMI) environments. Literature in both of these areas was chosen for review because (1) both MSP and CMI employ a criterion-referenced, individualized instructional philosophy, (2) MSP and CMI are both based on the concept that the student is an active participant in the learning process and, as such, is responsible for his or her own learning, and (3) it has been recognized that (a) the instructor's role in both types of systems must change to accommodate the change in student role and (b) the new role of the instructor has, to date, been only tangentially addressed by those involved in either MSP or CMI systems.

Table 2 presents a list of studies that have addressed new instructional roles in MSP and CMI systems within the last decade, and indicates how authors of these studies perceive the role of the instructor in these systems. The ten roles listed were identified by the authors as the major functions of instructors that are important for effective student learning. These roles are discussed in the following paragraphs.

Table 2

Current Instructor Role Definitions for CMI and Self-Paced Instructional Systems

| Studies Reviewed | Instructor Roles | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Administrator | Classroom Manager | Counselor/Advisor | Diagnostician | Evaluator | Learning Strategies Expert | Prescriber | Resource Manager | Technical Expert | Tutor/Consultant |
| Manual Self-Paced Systems: | | | | | | | | | | |
| Arlin & Whitely, 1978 | | | | | | X | | | | |
| Harris, 1971 | | | X | | | | | | | |
| Johnson, 1977 | | | X | | X | | X | | | X |
| Lamos, 1971 | | | X | | X | X | | | X | |
| Lindvall & Bolvin, 1969 | X | X | X | X | X | X | | | | |
| L.A. City Schools, 1978 | X | | X | | | | | | X | X |
| McKee, 1972 | | X | X | X | | X | | | | |
| Robin, 1977 | X | | X | | X | | | | | X |
| Computer-Managed Systems: | | | | | | | | | | |
| Baker, 1971 | | X | X | | | X | | | | |
| Bunderson, 1970 | | | X | X | | | X | X | | |
| Campbell, 1977 | | | X | | | | | | | |
| Cartwright & Cartwright, 1973 | | X | | | X | | | X | | |
| Dick & Dodl, 1970 | | | | | X | X | | | | |
| Hansen & Harvey, 1970 | | | X | X | | X | X | | | |
| Hess & Tenezakis, 1973 | | | X | | | X | | | | |
| Kerr & Harrison, 1979 | | | X | | | X | | | X | X |
| King, 1975 | | | | | | | X | X | | X |
| Middleton et al., 1974 | | | | | | | | | X | |
| Nachtigal, 1978 | | | | | | | | | | X |
| PLATO-CDC, 1979 | | | X | | | X | X | X | X | X |
| Summers, Pelletier, & Spangenburg, 1977 | X | | X | | | | | | | X |
| Wang, 1975, 1976 | X | X | | X | X | X | X | | | X |

1. The Administrator role is assumed to include behaviors such as special bookkeeping and recording of student characteristics or performance variables that are important for instructors to know in managing the classroom or providing individualization.

2. The Classroom Manager role includes activities such as planning and organizing classroom activities and procedures, allocating time for general supervision activities, planning small group instruction sessions, setting up procedures for individual tutoring and counseling, supervising the work of paraprofessionals (e.g., technicians or teacher aides), studying and evaluating the system so as to improve its overall operation, and developing immediate and long-range plans for meeting the needs of students.

3. The Counselor/Advisor role includes all of those skills necessary for creating a warm, personalized atmosphere, effectively interacting with many different types of students, effectively resolving interpersonal conflicts, responding quickly and accurately to student needs, and generally emphasizing the social and affective components of learning.

4. The roles of Diagnostician, Evaluator, Learning Strategies Expert, and Prescriber, taken together, describe a process in which the instructor must be skilled in those behaviors required to accurately assess student learning problems, evaluate areas of student deficiencies or learning needs, determine what learning strategies would best remediate or compensate for particular learning problems, and determine the best way to implement a particular learning prescription within the constraints of the instructional environment. Further, within the Learning Strategies Expert role, an instructor is, for example, responsible for helping students learn how to personalize and internalize course materials, take tests effectively, remember information, and see the course as a place where they have opportunities to manage their own instruction and take responsibility for their own learning.

3. The Resource Manager role requires that instructors understand appropriate student characteristic/instructional resource matches, and that they utilize this information in selecting, monitoring, and managing the available instructional resources.

6. The role of Technical Expert assumes that instructors are well versed on all course content areas, such that they can perform remedial assistance as required on an individual student basis.

7. The role of Tutor/Consultant assumes that instructors can perform the necessary tutoring for students needing additional technical information or more in-depth explanations of difficult concepts. In addition, as Hess and Tenezakis (1973, p. 1324) state, in the Tutor/Consultant role, the instructor is responsible for acting "as a synthesizer, a catalyst for new ways of organizing information and ideas, and a leader in group work."

Table 2 shows that the Administrator role is relatively more important in MSP environments than in CMI environments. This finding would be expected based on the computer's ability to perform many of the record-keeping functions required by humans in an MSP environment. It is interesting to note, however, that Wang (1975, 1976) and Summers et al., (1977), who cited the role of administrator as an important CMI instructor activity, are intimately involved with large-scale, operational CMI systems. For example, Summers et al., in a task analysis of the work of CMI personnel in the AIS, indicated that 37 percent of the instructors' time was devoted to performing administrative duties. Given that the computer is designed to perform many of these functions, it seems possible that the large proportion of instructional time being spent on administrative chores is a result of "using technology as a device for keeping people at arm's length" (Goshen, 1971, p. 13). That is, the lack of specific training in their new CMI instructor roles--including training in counseling and learning strategies skills--may have indirectly caused CMI instructors to perform those skills that they did possess and felt confident about performing (i.e., administrative and record keeping skills). In other words, instructors without adequate role training in such skills as counseling and learning may fixate on the

administrative role and ignore the more difficult, but substantially more important, CMI roles.

About the same proportion of studies on MSP and CMI view the Classroom Manager role as important. This role is seen somewhat differently in these two environments, however, with more emphasis being given to the interplay between Classroom Manager and Resource Manager in the CMI setting. This difference can be said to be primarily due to the fact that CMI courses generally employ more diverse and numerous instructional alternatives for individualization, using the computer to manage this adaptive decision-making process. This increased individualization--combined with the increased need for resource scheduling--leads to the necessity of having an effective and efficient instructional manager work with available computer support in allocating resources to meet individual student needs. As Baker (1971, p. 68) has stated, in a CMI environment, the computer implements:

> . . . a carefully orchestrated interaction among pupils, instructional procedures, and instructional materials, managed by the teacher. The teacher should use the computer as a vehicle for obtaining the timely, accurate, and relevant information needed to fulfill the role of educational manager (underlines added).

The instructional roles of Counselor/Advisor, Learning Strategies Expert, and Tutor/Consultant are also seen to be of equal importance in CMI and MSP environments, according to the studies cited in Table 2. On the other hand, the Diagnostician and Evaluator roles are seen as relatively more important by those writing from an MSP perspective, while the Prescriber and Resource Manager roles are seen as relatively important from a CMI perspective. The lack of computer-supported diagnosis and evaluation capabilities in MSP are seen as primarily responsible for the first difference; again, the reason the Prescriber and Resource Manager roles are viewed as more important in the CMI setting may be the increased quantity of instructional options available to the instructor in CMI. With the computer assimilating and reporting large quantities of data on each student, the instructor has more information to use in matching the individual with the most effective training resource available, and course personnel

are--at least theoretically--free to spend more time to develop these instructional alternatives in a CMI setting. While it is recognized that the computer can and often does assume much of this prescriptive function, those discussing the importance of the Prescriber role feel that the instructor enhances individualized prescriptions by adding his or her affective and observational information to the total picture. Thus, by talking with students and observing their classroom behavior, it is felt that the CMI instructor can improve the individualized prescription generated by the computer.

Finally, about the same proportion of MSP and CMI authors view the Technical Expert role to be important--although this proportion is small in both instructional contexts. The exact reasons for the small proportion of persons citing this role are not known, but it can be hypothesized that this particular role is often considered so obvious as to be an assumed "given." In addition, being a technical expert is something required by any good instructor--regardless of whether they are involved with traditional, lock-step instruction or with self-paced individualized instruction. The only difference is that, in the latter context instructors need to be technically competent over all parts of the course, at all times, rather than having to cover one unit at a time as in traditional instruction.

To summarize, then, the major roles of self-paced and/or individualized instructors are seen to be those of Counselor/Advisor, Learning Strategies Expert, and Tutor/Consultant. Secondary roles are those of Evaluator, Prescriber, and Resource Manager; and tertiary roles are those of Administrator, Classroom Manager, Diagnostician, and Technical Expert. These new instructor roles would thus seem to require that CMI instructors (1) possess strong interpersonal skills, (2) be knowledgeable not only about the subject matter being taught, but also about different learning strategies and their relationship with different training resources, and (3) understand and execute effective managerial and organizational techniques.

## Comparison of Theoretically and Empirically Derived CMI Instructor Roles

It is now of interest to compare how these empirically-derived "ideal" CMI instructor roles compare with those theoretically-based roles identified on pages 13 and 14. It will be recalled that seven basic theoretical CMI instructor roles were identified and classified into those roles that were primarily concerned with learning management and those that were primarily concerned with the facilitation of learning. Specifically, the Learning Manager roles were those of Planner and Implementer/Monitor, while the Learning Facilitator roles were those of Evaluator, Diagnostician, Counselor/Advisor, Remediator, and Tutor/Modelor. Comparing these seven roles with the ten "ideal" roles discussed earlier in this section, it can be seen that the "ideal" roles of Administrator and Classroom Manager are functionally equivalent to the theoretical roles of Planner and Implementor/Monitor. The "ideal" roles of Counselor/Advisor, Diagnostician, and Evaluator are obviously equivalent to the theoretical roles of Counselor/Advisor, Diagnostician, and Evaluator, and the "ideal" roles of Learning Strategies Expert, Prescriber and Resource Manager become subsets of the theoretical role of Remediator. Finally, the theoretical role of Tutor/Modelor encompasses the "ideal" roles of Technical Expert and Tutor/Consultant.

It can thus be seen that the "ideal" CMI instructor roles are not substantially different from those identified via a theoretical analysis. In practice, this difference appears to be one of focus or emphasis (e.g., Summers et al., 1977; Wang, 1975, 1976), further substantiating the need for some type of instructor training in all those skills subsumed in both the Learning Manager and Learning Facilitator roles. In addition, taken together, these theoretical and empirical frameworks enhance and enrich each other such that a detailed and inclusive description of instructor behaviors per role can be derived for the theoretical CMI Instructor Role Specification.

## THEORETICAL CMI INSTRUCTOR ROLE SPECIFICATION OUTLINE

### Purpose and Requirements of Theoretical Role Specification

The overall purpose for specifying theoretically-based CMI instructor roles is to provide an ideal model against which actual military CMI instructor roles can be evaluated and a responsive training package can be defined. To facilitate the efficiency and effectiveness of evaluating the ideal role model against actual roles, the specification of theoretically-based CMI instructor roles should be in an easy to use and interpret format. This section presents a suggested general format for this Theoretical CMI Instructor Role Specification.

### General Format of Theoretical Role Specification

A format similar to that shown in Table 3 is recommended for the Theoretical CMI Instructor Role Specification. As shown, this format allows for a listing of theoretically-based instructor roles (and their accompanying behaviors) and spaces for annotating the extent to which actual CMI instructor roles and behaviors deviate from the theoretically-based roles for the military CMI environments of interest (i.e., Navy-Memphis, Navy-Great Lakes, AIS, Marine Corps). In addition, the suggested specification format allows for annotating deviations of actual from the ideal by technical training schools or courses of interest. (It should be noted that, at the time the report was written, it was unclear whether annotations of actual CMI instructor behaviors will be in a binary (yes-no) or rating scale format.)

The methods to be used in collecting data on actual CMI instructor roles at the selected military CMI sites have yet to be determined. It is assumed, however, that semistructured interviews or questionnaires or both are viable approaches. Thus, the data on actual CMI instructor roles will be collected via means other than the use of the Theoretical CMI Instructor Role Specification, such as shown in Table 3. These data on actual CMI instructor roles, then, will be condensed and entered into the specification following data collection.

**Table 3**

**Theoretical CMI Instruction Role Specification Outline**

| Ideal CMI Instructor Roles/Behavior | Relative Contribution To Student Learning | | | | | Actual CMI Instructor Roles | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Very Little | | | | Very Much | Navy-Memphis | | Navy-Great Lakes | | | AIS | USMC |
| | 1 | 2 | 3 | 4 | 5 | AVA | AFUN | BE&E | PE | IM | PME | EFUN |
| Learning Manager | | | | | | | | | | | | |
| Planner | | | | | | | | | | | | |
| Behavior 1 | | | | | | | | | | | | |
| Behavior n | | | | | | | | | | | | |
| Monitor | | | | | | | | | | | | |
| Behavior 1 | | | | | | | | | | | | |
| Behavior n | | | | | | | | | | | | |
| Learning Facilitator | | | | | | | | | | | | |
| Evaluator | | | | | | | | | | | | |
| Behavior 1 | | | | | | | | | | | | |
| Behavior n | | | | | | | | | | | | |
| Diagnostician | | | | | | | | | | | | |
| Behavior 1 | | | | | | | | | | | | |
| Behavior n | | | | | | | | | | | | |
| Counselor/Advisor | | | | | | | | | | | | |
| Behavior 1 | | | | | | | | | | | | |
| Behavior n | | | | | | | | | | | | |
| Remediator | | | | | | | | | | | | |
| Behavior 1 | | | | | | | | | | | | |
| Behavior n | | | | | | | | | | | | |
| Modelor | | | | | | | | | | | | |
| Behavior 1 | | | | | | | | | | | | |
| Behavior n | | | | | | | | | | | | |

Remaining Content of Theoretical Role Specification

Given the general specification format recommended in the preceding section, information to be added to this specification includes (1) a complete description of instructor behaviors within each theoretically-based role and (2) a specification of the relative contribution of these behaviors to student learning. This additional information will be derived from an analysis of each role and a determination of the specific, measurable behaviors required to perform each role. Information from the literature review will be used in the analysis of theoretically-based instructor roles. During the description of behaviors required by each role, a determination will be made of how these behaviors can best be measured and evaluated. Relevant theoretical frameworks will also be used in determining the relative contribution of each instructor behavior per role. This determination will assist in defining the relative amount of time that should be spent in training instructors to perform these various behaviors.

In specifying the relative contribution of each theoretically-based CMI instructor behavior per role to student learning, it is recommended that a rating scale approach be used. For example, based on theoretical empirical information, judgments about whether the behavior contributed "Very Little" or "Very Much" to student learning, on a 5- or 7-point scale, could be made. These judgments could then be annotated on the Theoretical CMI Instructor Role Specification, as shown in Table 3.

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